Teaming for Teaching: Producing Effective Systems Engineers for the 21st Century

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Abstract. As we enter the 21st century, the demands on our technological personnel are greater than ever. Universities wishing to meet this growing demand for education in systems engineering are facing a scarcity of qualified seasoned systems engineers who can teach the topic. This gap between the need and the capability to train personnel is not an easy one to fill. This paper applies an industrial solution to the problem faced by individual universities, namely synergistic teaming to provide educational opportunities greater than those can could be provided by the individual institutions.

INTRODUCTION

As we enter the 21st century, the demands on our technological personnel are greater than ever. For example:

- Major government funded systems development has traditionally been characterized by cost and schedule overruns and other (spectacular) failures.
- Employers need effective systems engineers to meet the demands of producing modern complex systems within the constraints of schedule and budget.
- Building modern complex systems or "systems of systems" and other systems with international subcontracts and partners requires that the builders have a global perspective.

This gap between the need and the capability of the personnel is not an easy one to fill. Universities wishing to meet this growing demand for education in systems engineering are facing a scarcity of qualified seasoned systems engineers who can teach the topic. Consequently the instruction provided to students may not be at the level program directors and students desire.

This paper proposes applying an industrial solution to the problem faced by individual universities, namely synergistic teaming to provide educational opportunities greater than those can could be provided by the individual institutions.

The traditional approach of teaching theory in academia does not work too well in systems engineering because it is a field that is evolving rapidly. By the time a methodology gets into a syllabus the state of the art has moved on. In addition, while there are few proven theoretical methodologies in the field, any literature search of the field will show there are a lot of empirical approaches that have been published as symposia papers.

Luckily, the part-time or adjunct faculty teaching systems engineering tend to be senior level people who are doing systems engineering as a full time job, and are teaching part time. These people, not only teach the theory as expressed in the text books, they are in an excellent position to comment on the theories and tell their students what works and what doesn't work. In effect they have returned to the tried and true approach to teaching engineering skills, namely the master-apprentice model. This is the teaching model adopted in the Graduate School of Management and Technology at University of Maryland University College (UMUC) from teaching courses in the Master of Software Engineering and Master of Science in Computer Systems Management Degrees.

Even resorting to adjunct faculty does not provide enough qualified instructor candidates. While there are many experienced practitioners who could teach systems engineering in

general they tend not to have terminal degrees[1]. The accreditation criteria for universities which requires a specific minimum of instructors with terminal degrees for teaching at the graduate level thus tends to prohibit the use of otherwise qualified instructors and significantly reduces the pool of available talent. Universities which are able to find experienced qualified practitioners with terminal degrees hire them to teach and then may find out that, while a particular person may have an excellent grasp of the subject, they cannot teach adult learners. And, as this situation is only discovered in the classroom, it becomes a lose-lose situation. The students suffer due to the lack of instruction, and the instructor goes through a bad experience.

Teaming has traditionally not been viewed as a solution to this problem because universities in a geographical area are competing for students among the same population. However the advent of the world wide web coupled with the growth of distance learning technology have made teaming a viable solution to the problem in certain situations.

Consider the requirements for successful teaming and the implications thereof.

CONCEPT OF OPERATIONS

As with any good engineering project, it begins with a vision, commonly known as a concept of operations.

A team of universities, each well known in their area (geographical or expertise) offer a joint graduate degree in systems engineering. As far as the team is concerned:

- One or more topics is/are taught only by the institution with the recognized expertise. The University of South Australia (UniSA), for example, would provide expertise in the systems engineering topics by virtue of its association with the System Engineering and Evaluation Center (SEEC) in suburban Adelaide.
- Several topics are taught by two or more institutions
- The remainder of the topics is taught by all institutions in the team.
- The team is made up of institutions well separated by distance. Each is located in an area with potential students. For example UniSA could team with an institution in England, another in the Washington DC area of the United States of America and one in India[2].

The courses are offered in several formats to suit the lifestyle of the adult learner. These include:

- Traditional synchronous classroom sessions over the course of a semester.
- On-line sessions over the course of a semester via distance education in synchronous or asynchronous formats.
- Short three or five day synchronous seminars[3].
- The executive format of consecutive synchronous weekend sessions enhanced with web-assisted asynchronous extensions.

Students take courses from the institution of choice via their method of choice. In the situation in which a course is offered by more than one institution, the students will soon learn which institution and which instructors are more suited to their needs and plan their studies accordingly. This competition for students will tend to increase the quality of the courses and ensure that they remain reasonably current. For example, several students in the now terminated joint Master of Software Engineering (MSWE) degree offered by the University of Maryland at College Park (UMCP) and UMUC did express preferences as to institutions and instructors in acquiring knowledge of specific topics[4].

While each university locates instructors, the pressure on program directors to find instructors for every course is lessened.

[1] A terminal degree is generally one at the Doctorate level.

[2] England provides entry in the European Union as well as the British defense industry. Washington DC is the location of many contractors providing systems engineering services to the U.S. Government. India is a growing area in the field of systems and software engineering and students seem to be one of its major exports.

[3] The short seminars allow for instructors to be flown to their students, in the manner in which UniSA personnel offer courses in the United Kingdom and makes use of foreign talent in Australia.

[4] It was not at all one-sided. Some students preferred UMCP, others UMUC.

REQUIREMENTS FOR TEAMS

Theoretically forming teams should not be too difficult, in practice it will be a major accomplishment. The requirements for successful teams in academia are the same as those for successful teams in industry, namely

- Each member has something to contribute and lack some capability provided by other members of the team.
- The members have compatible cultures. In the United States there tends to be two kinds of universities, the research university and the teaching university. As UMUC and UMCP found out, incompatible cultures are a major impediment towards forming a successful team.
- The institution understands the needs of, and cares for adult learners.
- The institutions provide most if not all of the systems engineering body of knowledge, or at least the subjects taught in current degrees in systems engineering.
- The full-time faculty at each institution have worked in the field successfully before entering into academia.
- Most of the classes are taught by adjunct faculty who are doing what they are teaching. If they are not doing it while teaching, then they should have done it within the last two years.
- One institution has to administer the program, the others provide the quality control. This is the principle of checks and balances.
- As important as the instruction is the access to current journals and textbooks, and databases. The ability to provide these capabilities is critical when the student body is at a distance. Providing on-line access to the data is a service provided by more and more institutions, however providing access to physical books and journals is more difficult. While several freight carriers can provide this capability overnight in the continental United States at a reasonable cost, the cost of providing the service internationally is still prohibitive. The international members of the team provide the physical materials in their geographical areas.

In practice however, teaming will not be simple. However, it is the way of the future. Experience has already shown that it requires:

- major commitments by each institution and,
- personnel in each institution committed to the vision of the team and providing their students with the best educational opportunities they can.

- The challenge in forming a successful long-lived team is that it will be a true example of engineering a complex system and may even end up as a case study in one of its classes.

OTHER BENEFITS OF TEAMING INTERNATIONALLY

Other benefits include:

- The institutions in the team are not competing for students who wish to study in the classroom.
- Students are exposed to other ways of doing things in other nations and cultures. This exposure comes from both the instructors and their classmates.
- Students in the on-line classes work in teams on projects with people. This constructivist approach to learning provides both the global perspective and the ability to interact with co-workers in distant time zones.
- Australian and British universities offer research degrees at the Masters and Doctoral levels which do not have residency requirements. By teaming with a Stateside university, the degrees would be available to the professional in the USA who does not have the time to spend in a ‘residency’. This opens a new market to the offshore universities. In addition, as well as raising the effectiveness of systems engineering, making this type of degree available in the USA would, in the long term, provide a greater pool of subject matter experts with terminal degrees for teaching in the classroom.

IT IS HAPPENING

Teaming is already starting to happen. For example:

- UMUC and UMCP had a joint graduate program in Software Engineering. When the joint program terminated in May 1999, UMUC converted the degree to the on-line format while continuing the phase out of the joint students and as of September 1999 it

was their fastest growing program (Kasser, et al., 1999).

- UniSA is actively collaborating with University College, London in providing courses in systems engineering.

CONCLUSIONS

Teaming for teaching systems engineering offers benefits to both institutions and students. As such it should only be a matter of time before the first such team is formed and offers world class graduate education in systems engineering.

REFERENCE

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BIOGRAPHY

Dr. Kasser has more than 25 years of award winning experience in management and engineering. He is an Associate Research Professor at the Systems Engineering and Evaluation Centre at the University of South Australia. He also teaches software engineering at the University of Maryland University College via Distance Learning. He is a recipient of NASA's Manned Space Flight Awareness (Silver Snoopy) Award for quality and technical excellence. He is a Certified Manager and a recipient of the Institute of Certified Professional Manager's 1993 Distinguished Service Award. He is the author of Applying Total Quality Management to Systems Engineering published by Artech House and more than 30 journal articles and conference papers. His current interests lie in the areas of applying systems engineering to organizations and using technology to improve the practice of management.